Internship Program Report

By

K. vamsi krishna-19485A0212

GUDLAVALLERU ENGINEERING COLLEGE

(An Autonomous Institute with Permanent Affiliation to JNTUK, Kakinada)
(Sponsored by A. A. N. M & V. V. R. S. R Educational Society, Gudlavalleru)
Approved by AICTE, New Delhi and Permitted by AP State Government
Accredited by NAAC with 'A' Grade

Counselling Code : GDLV

In association with

Smart Internz

Contents

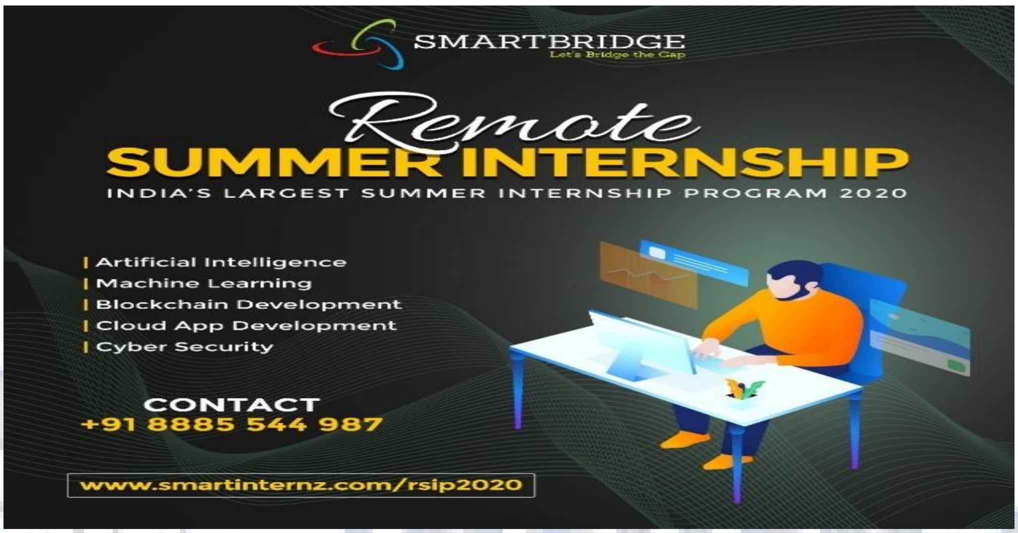
Introduction

Internship program arranged by GUDLAVALLERU ENGINEERING COLLEGE in association with Smart Internz, Hyderabad for the benefit of 3rd /4th year EEE batch 2018-2022 on Electrical Detailed design Engineering for Oil& Gas, Power and Utility industrial sectors.

Program organiser

Smart Bridge, Hyderabad.

Pioneer in organising Internships, knowledge workshops, debates, hackathons, Technical sessions and Industrial Automation projects.



Courtesy

Dr. Sri B. Dasu – HOD – EEE, GEC

Mr. Rama Krishna –

Mr. Ramesh V - Mentor

Mr. Vinay Kumar - System Support

Mr. Harikanth – Softwar/Technical Support

Program details

Smart Internz program schedule: 4 weeks starting from 3rd May 2021

Daily schedule time shall be 4PM to 6.30PM

Mode of Classes: On line through ZOOM

Presenter: Mr Ramesh V

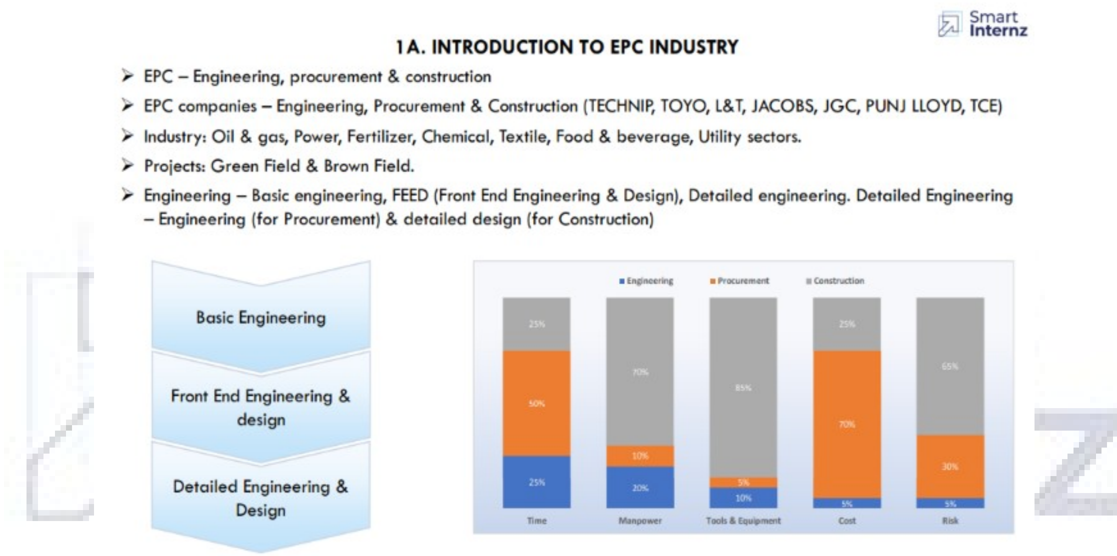
Internship program

We have been given the opportunity to learn and interact with industry experienced engineering specialist to learn the Electrical detailed design engineering for various industrial sectors.

3rd May2021: Introduction to EPC Industry

1	EPC Industry & Electrical Detailed Engineering	EPC Industry	Introduction
		Engineering	Types of Engineering
		Procurement	Engineering role in procurement
		Construction	Engineering role during construction

Topic details:



Engineering phases, Engineering deliverables (drawings & documents) list, Design Engineer role at various phases of project.

4th May2021: Engineering documentation for EPC projects

2	Electrical Design Documentation	Engineering Deliverables list	Sequence of deliverables
		Detailed Engineering work flow	Detailed engineering process
		Document transmission	Document submission and info exchange
		Deliverables types	Different types of deliverables

Topic details:

2B. ELECTRICAL DETAILED ENGINEERING DELIVERABLES

- Electrical Consumer List (Excel or SPEL or ETAP)
- Single Line Diagram: Power Distribution concept, Detailed Metering & Protection Diagram (ACAD)
- Network calculations: Load flow, short circuit, motor starting, internal arc (Word/Excel/ETAP)
- Power Balance: Transformer Sizing (Excel or SPEL or ETAP)
- UPS, DC Charger & Battery sizing (Excel or ETAP)
- Cable Sizing, Tray sizing (Excel or SPEL)
- Grounding calculations (Excel/ETAP)
- Lightning Protection calculations (Excel)
- Illumination calculation (3D modeling based using DIALUX)
- 3D Modeling (PDS/PDMS/Smart Plant 3D)
- Lists/Schedules: LCS lists, cable schedules, DCS Signal Exchange (Excel or SPEL)
- Layouts: SS / CR, Haz. Class, Earthing / Lightning protection, Cable routing, Illumination (ACAD)
- BOQs or Material Take-offs (Excel or SPEL)
- Cable termination details / Inter-connection Diagrams (Excel or SPEL)
- Electrical equipment Installation details (ACAD)
- Relay Co-ordination & Selectivity Studies (Excel or ETAP)

Here we observed that how to do a project and sequence of approach,Approach to detail design and overall plant distribution system

5th May 2021:Engineering documentation for commands and formulae

3	Document & Drawingtools	MS Word	Report / Calculations formats

Topic details:

3A. MS WORD COMMANDS

Word Shortcut Keys

Command Name	Keys
All Caps	Ctrl+Shift+A
Apply List Bullet	Ctrl+Shift+L
Auto Format	Alt+Ctrl+K
Auto Text	F3
Bold	Ctrl+B
Cancel	ESC
Center Para	Ctrl+E
Change Case	Shift+F3
Clear	Del
Close or Exit	Alt+F4
Copy	Ctrl+C
Create Auto Text	Alt+F3
Cut	Ctrl+X
Double Underline	Ctrl+Shift+D
Find	Ctrl+F
Help	F1
Hyperlink	Ctrl+K
Indent	Ctrl+M
Italic	Ctrl+I
Justify Para	Ctrl+J
Merge Field	Alt+Shift+F
New Document	Ctrl+N
Open	Ctrl+O
Outline	Alt+Ctrl+O
Overtype	Insert
Page	Alt+Ctrl+P
Page Break	Ctrl+Return
Paste	Ctrl+V
Paste Format	Ctrl+Shift+V
Print	Ctrl+P
Print Preview	Ctrl+F2
Redo	Alt+Shift+Backspace
Redo or Repeat	Ctrl+Y
Save	Ctrl+S
Select All	Ctrl+A
Small Caps	Ctrl+Shift+K
Style	Ctrl+Shift+S
Subscript	Ctrl+=
Superscript	Ctrl+Shift+=
Task Pane	Ctrl+F1
Time Field	Alt+Shift+T
Underline	Ctrl+U
Undo	Ctrl+Z
Update Fields	F9
Word Count List	Ctrl+Shift+G

Function Keys	
F1	Get Help or visit Microsoft Office Online.
F2	Move text or graphics.
F3	Insert an AutoText (AutoText: A storage location for text or graphics you want to use again, such as a standard contract clause or a long distribution list. Each selection of text or graphics is recorded as an AutoText entry and is assigned a unique name.) entry (after Microsoft Word displays the entry).
F4	Repeat the last action.
F5	Choose the Go To command (Edit menu).
F6	Go to the next pane or frame.
F7	Choose the Spelling command (Tools menu).
F8	Extend a selection.
F9	Update selected fields.
F10	Activate the menu bar.
F11	Go to the next field.
F12	Choose the Save As command (File menu).

Checks to be done:

- Page setup
- Spelling
- Grammar
- Punctuation
- Paragraphs
- Overall presentations
- Tables & pictures to be numbered and titled
- Document name & date of versions

Here we need to check the Page setup,spelling,Grammer,Punctuation,Paragraphs,Overall prasentations,Tables & pictures to be numbered and titled at last we check the Document name & date of versions.

10th May 2021:Electrical documentation for Typical diagrams

4 	Electrical documentation for typical diagrams	Single line diagram	Overall plant description

Here we observed that how to do a project and Sequence of approach,Approach to detail design and Overall plant distribution system.

11th May 2021:Classification of transformers and Generators

5	Classification of transformer and generators	Transformers	Sizing &Selection
		Generator	Diesel generator set,DG set selection

Topic details:

Transformer shall include a primary disconnect on the incoming power source. The disconnect means shall be either a breaker or a load break primary switch that is fused.

5A. TRANSFORMERS

1 Ph. Pad mounted Residential lighting

3 Ph Pole mounted Commercial/ Residential/ street lighting

3 Ph Oil filled (ONAN) Distribution type for industrial & commercial

3 Ph Oil filled (ONAF) Power transformer for industrial

3 Ph. Auto transformer for large motor starting & line regulation

3 Ph. Servo Stabilizer for hospital and critical equipment

3 Ph. Dry type indoor for commercial/industrial/data centers

Diesel generator set

The packaged combination of a diesel engine, an alternator and various ancillary devices such as base, canopy, sound attenuation, control systems, circuit breakers, jacket water heaters, starting systems etc., is referred to as a Diesel Generating Set or a DG Set in short.

DG sets are selected based on the load they are intended to supply power for, taking into account the type of load, ie emergency (stand by) or for continuous power (prime), and the size of the load, and size of any motors to be started which is normally the critical parameter.

11kV/6.6kV Diesel generator sets for standby / Emergency power supply

415V Diesel generator sets for standby / Emergency power supply

240V 1 ph diesel generator set for lighting and & small power only

12th May 2021:Classification of Switchgear construction and power factor improvement

6	Classification of switchgear construction and power factor	switchgear	Types
		Power factor improvement	Description

Topic details:

Switchgear

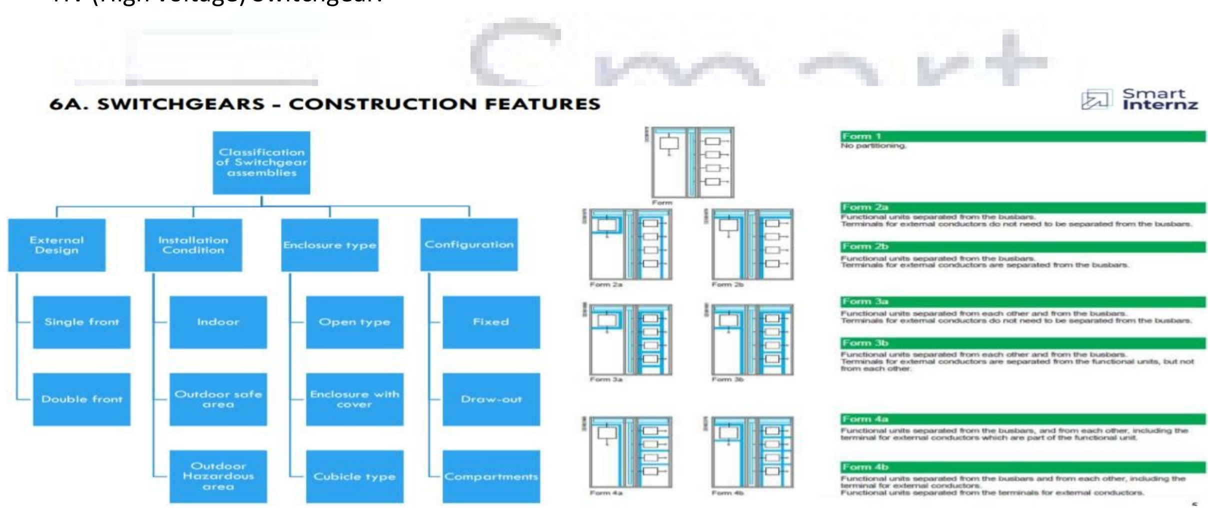
Switchgear includes switching & protecting devices like fuses, switches, CTs, VTs, relays, circuit breakers, etc. This device allows operating devices like electrical equipment, generators, distributors, transmission lines, etc.

There are three types of switch gears namely

LV (Low voltage),

MV (Medium voltage) and

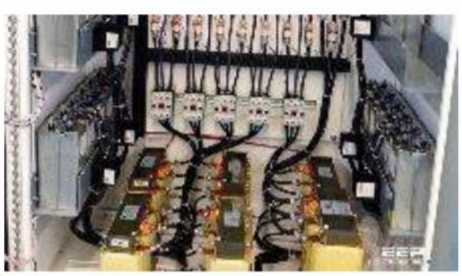
HV (High voltage) Switchgear.

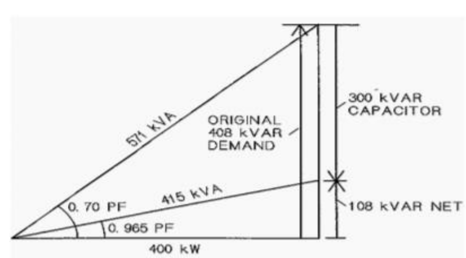


POWER FACTOR IMPROVEMENT

Power factor defined as the ratio of real power to volt-amperes and is the cosine of the phase angle between the voltage and current in an AC circuit.

Power factor penalties on demand charges range from none to a factor of 2 on the peak power demand.





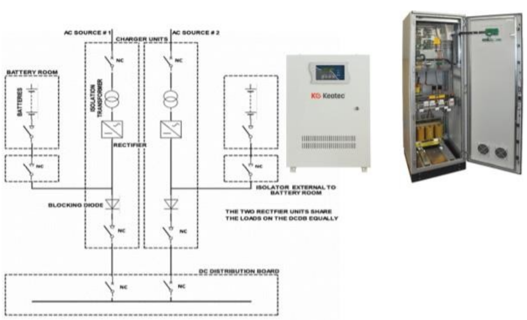
17th May 2021:Detailing about UPS system and Busducts

7	Detailing about UPS system and Busducts	UPS system	Types
		Busducts	Applications

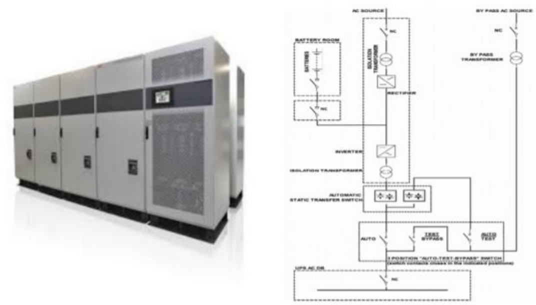
Topic details:

UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEMS

Power disturbances occur in the electrical system environment and critical applications like plant control systems, computer-based operations, telecommunications or any other system critical for operations shall have uninterruptible power supply.



110V or 220V DC
UPS System



110V or 230V
AC UPS System

Busducts

A sheet metal duct with aluminium or copper bus bars as conductor, and used as a reliable link for transferring power from one equipment to other at desired voltage levels, used as an alternate means for conducting electricity to cable bus and power cables.

Non-segregated
busduct

Sandwich type
busduct

18th May 2021:Detailing about Motor Starters and Sizing of motors

8	Detailing about Motor starters and sizing of motors	Motor starters	Methods
		Sizing of motors	Sizing selection

Topic details:

Motor Starters

The principal function of a motor starter is to start and stop the respective motor connected with specially designed electromechanical switches which are similar in some ways to relays. The main difference between a relay and a starter is that a starter has overload protection for the motor that is missing in a relay. So a starter has two main roles - to switch the power automatically or manually to a motor and at the same time protect the motor from overload or faults.

➢Direct-On-Line Starter

➢Rotor Resistance Starter

➢Stator Resistance Starter

➢Auto Transformer Starter

➢Star Delta Starter

Motor Sizing

LV motors – based on driven equipment shaft power + 10-15% margin to select nearest standard size. MV Motors - based on driven equipment shaft power + 5-10% margin and rounded off to nearest 10s. Voltage: 0.18 to 160kW LV, 200 to 1800kW 3.3/6.6KV, >2000 11kV also depends on availability

Selection after sizing

Type - Synchronous or Induction motor

Environment – hazardous area, dusty, saliferous, altitude,

Application – Pump, Compressor, fan, Lift/Hoist/Crane etc.

Duty – based on application S1, S2, S3, S4, S5, S6

Ingress protection – Dust & water, Enclosure – Explosion proof, industrial

Mounting – Horizontal, Vertical

Bearings – Single Ball, Double Ball, Roller, Sleeve.

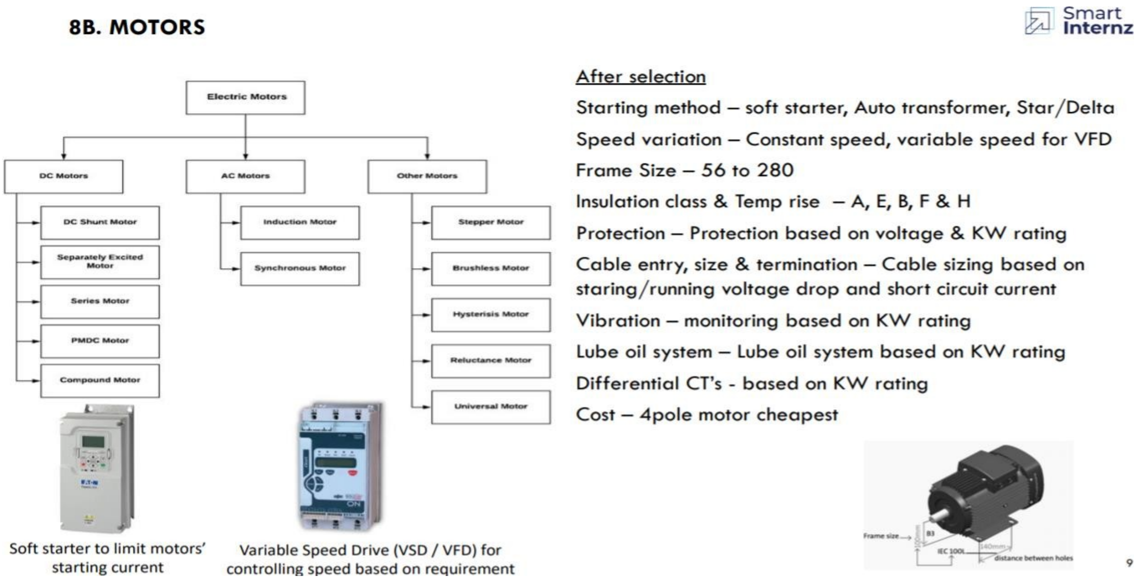
Cooling – TEFC, TETV, TENV, TEWC

Temperature detectors – Winding (6 nos.) & Bearing (2 nos.)

Starting & running torque – Based application

Load factor – 10 – 15 %

Efficiency – Energy efficient motors



19th May 2021:Describing about Earthing system and Lightening Protection

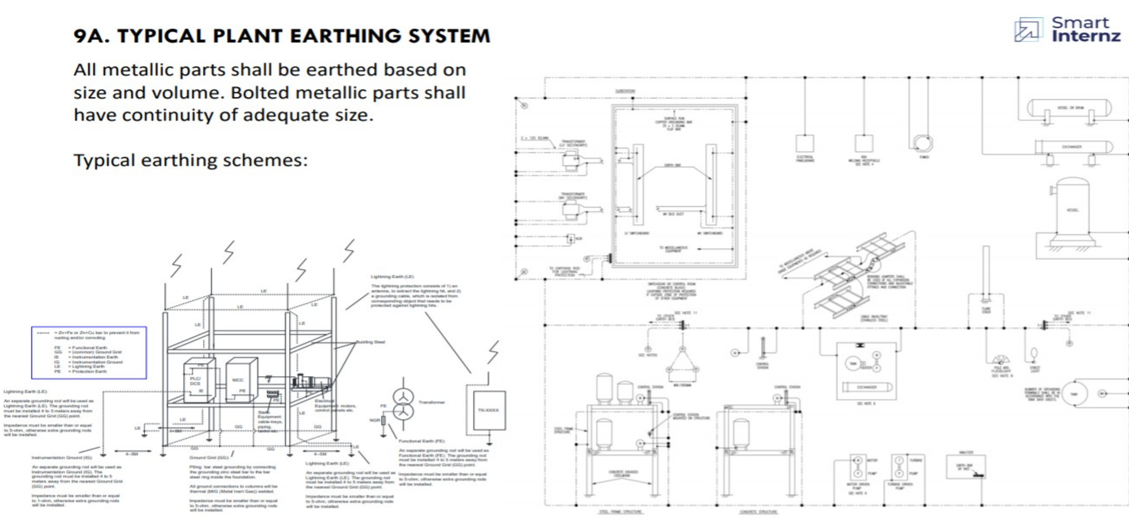
9	Describing about Earting system and lightening protection	Earthing system	Methods
		Ligtening protection	Description

Topic details:

EARTHING SYSTEM

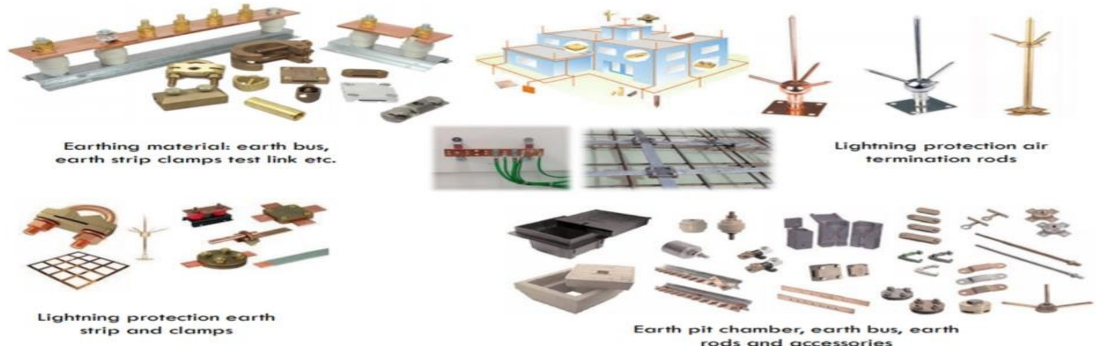
The purpose of earthing is to prevent damage to people and prevent or limit plant damage. Various earthing systems are provided with each earthing system is isolated from the other.

System earthing (usually copper material), body earthing (also called dirty earth, usually GI/copper material), earthing for lightning protection (usually GI/copper material), Clean earth system for instrumentation (usually copper material) and Telecom earthing system (usually copper material).



LIGHTNING PROTECTION SYSTEM

Lightning protection required for high rise structures and important buildings against lightning currents during thunder storms . Primarily Lightning protection system calculations are done based on soil resistivity, conductor material, coverage structure / Building to determine whether lightning protection is required or not . Earthing calculation for lightning protection system shall be same as described in previous chapter. Lightning protection layouts are prepared for showing lighting protection to tall structures/buildings, important/heritage buildings, Buildings with electrical & instrumentation control panels etc .



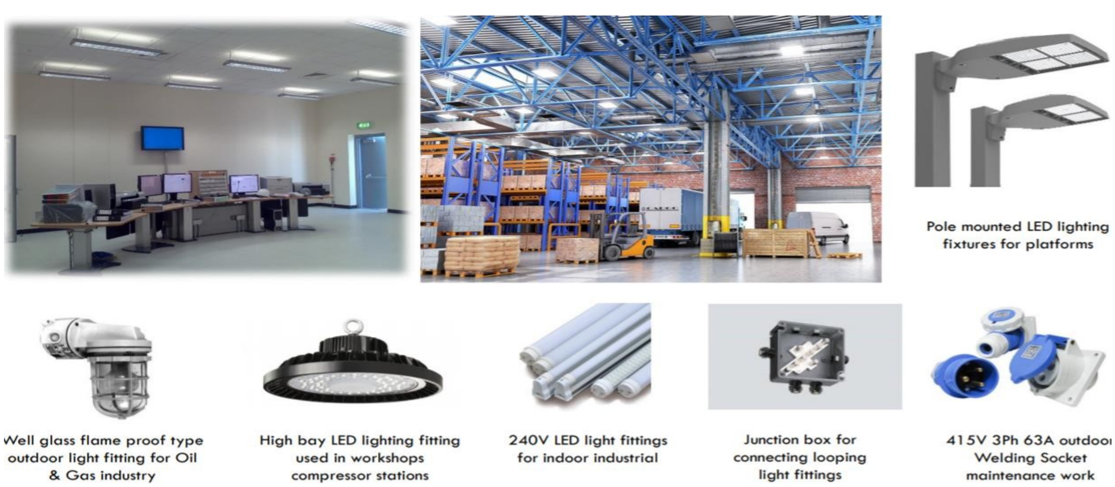
20th May 2021:Lightening or illumination system and calculations

10	Lightening or illumination system and calculations	Illumination system

Topic details:

LIGHTING OR ILLUMINATION

Lighting or Illumination systems are designed based purpose, color rendering, criticality. Industrial lighting load shall be grouped as normal, emergency and critical. Separate lighting DBs shall be provided for critical and emergency lighting load. Emergency lighting shall be 30% of total lighting fittings as per calculations. However the circuiting shall be done such that the emergency lights shall also be switched on during normal condition.



21st May 2021:Lightening or illumination systems using DIALUX software

11	Lightening or illumination system using DIALUX software	Illumination system	DIALUX software

Topic details:

11A. LIGHTING OR ILLUMINATION CALCULATIONS USING DIALUX SOFTWARE

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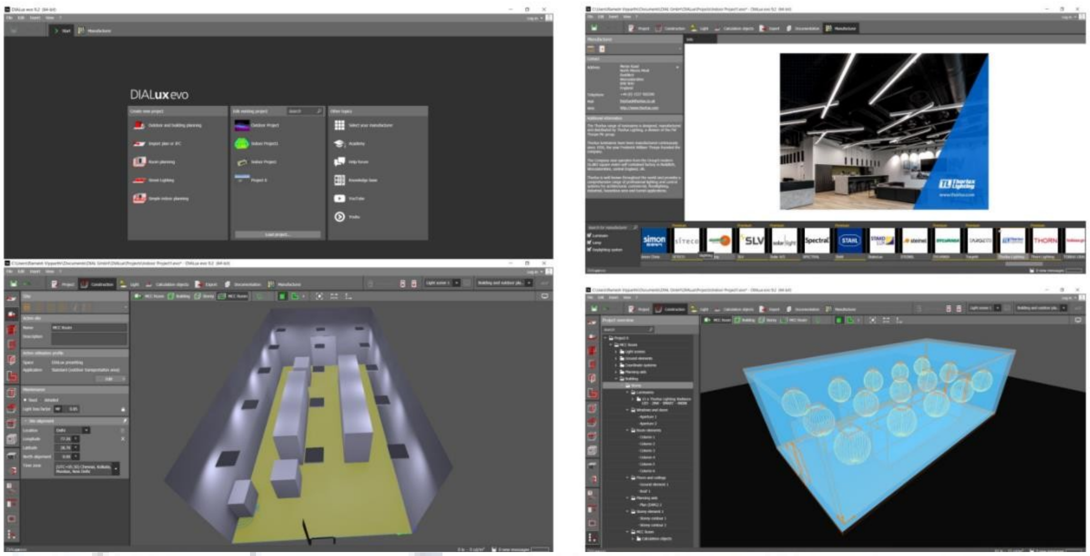
Dialux evo 5.9.2 software windows



24th May 2021:Cabling and their calculations and types

12	Cabling and their calculations and types	cable	Cabling specifications

Topic details:

12A. CABLING – CABLE SPECIFICATIONS

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Electrical Power cables:

Sizes: 3Cx2.5, 4Cx16, 3.5Cx95, 1Cx400 sq mm

Types: Al/PVC/SWA/PVC, Cu/XLPE/SWA/PVC, Cu/XLPE/AWA/PVC

Control Cables:

Sizes: 3Cx2.5, 7Cx2.5, 19Cx2.5, 24Cx2.5 sq mm

Types: Cu/XLPE/SWA/PVC

Instrumentation cables:

Sizes: 3Cx1.5, 2Px1.0, 5Tx1.0, 24Cx2.5 sq mm

Types: Cu/XLPE/I & C SCR/SWA/PVC

Telecom cables:

Sizes: Jelly filled 50Px0.4, 200Px0.4 sq mm

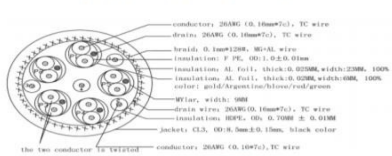
Types: Cu/twisted pair/PVC

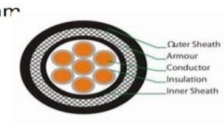
Fire Alarm cables

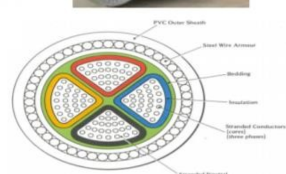
Sizes: 3Cx1.5, 3Cx2.5 sq mm

Types: Cu/LSZH/PVC

Cables are generally supplied in wooden drums or returnable steel drums. Depending on size and weight of the cable, the standard drum lengths are 250, 350, 500, 750, 1000, meters 2000 etc. cable shall be laid in cable trenches or overhead cable trays using vertical drum rollers.







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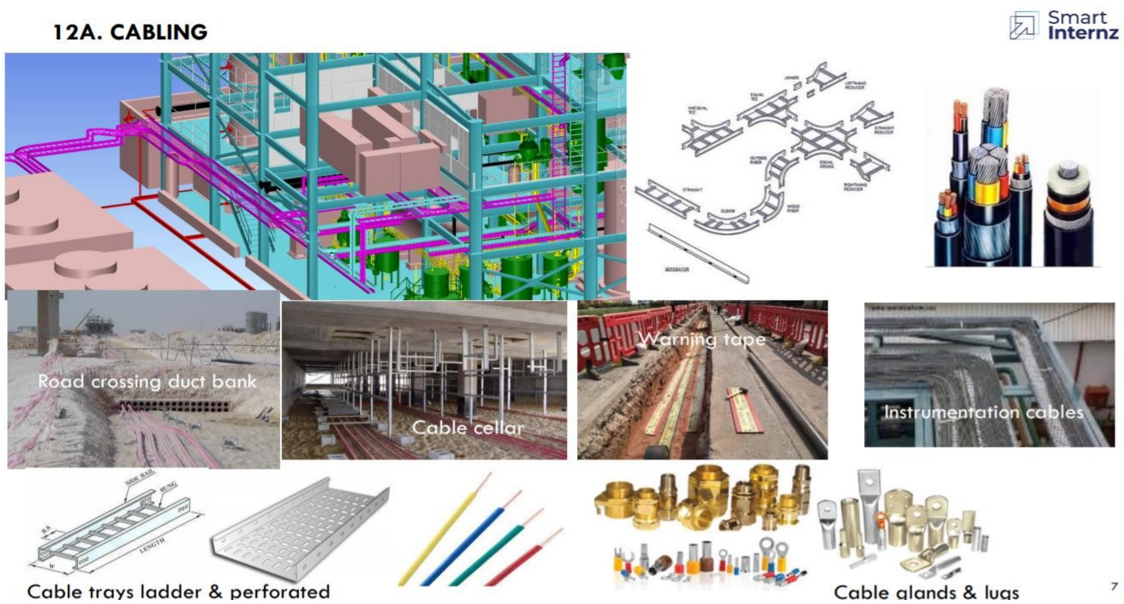

25th May 2021:Cabling calculations and cable gland selection

13	Cabling calculations and cable gland selection	Cable sizing	Cable glands

Topic details:

13C. CABLE GLAND SELECTION

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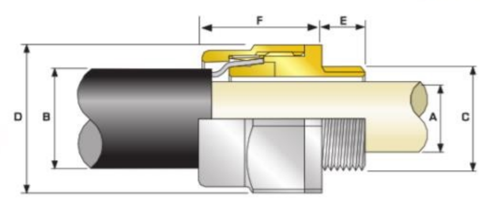
Cable glands are mechanical cable entry devices and can be constructed from metallic or non-metallic materials. Cable glands are used on all types of electrical power, control, instrumentation, data and telecommunications cables. They are used as a sealing and termination device to ensure that the characteristics of the enclosure which the cable enters can be maintained adequately.

Cable glands are made from Plastic, Brass Nickle plated, Aluminium & Stainless steel and they are Single compression type & Double compression type.

Important specifications for cable glands:

- The hole diameter is the maximum diameter of a cable.
- The cable diameter specifies the diameter of the cable that can be through the cable gland.
- The mounting hole diameter refers to the diameter of the barrier on which the gland is to be installed.



Cable Gland Selection Table
Refer to illustration at the top of the page.

Cable Gland Size	Available Entry Threads "C" (Alternate Metric Thread Lengths Available)		Cable Bedding Diameter "A"	Overall Cable Diameter "B"	Armour Range		Across Flats "D"	Across Corners "D"	Protrusion Length "F"
	Metric	Thread Length (Metric) "E"	Max	Max	Min	Max	Max	Max	
20S16	M20	10.0	8.7	13.2	0.8	1.25	24.0	26.4	35.2
20S	M20	10.0	11.7	15.9	0.8	1.25	24.0	26.4	32.2
20	M20	10.0	14.0	20.9	0.8	1.25	30.5	33.6	30.6
25	M25	10.0	20.0	26.2	1.25	1.6	36.0	39.6	36.4
32	M32	10.0	26.3	33.9	1.6	2.0	46.0	50.6	32.6
40	M40	15.0	32.2	40.4	1.6	2.0	55.0	60.5	36.6
50S	M50	15.0	38.2	46.7	2.0	2.5	60.0	66.0	39.6
50	M50	15.0	44.1	53.1	2.0	2.5	70.1	77.1	39.1
63S	M63	15.0	50.0	59.4	2.0	2.5	75.0	82.5	52.0
63	M63	15.0	56.0	65.9	2.0	2.5	80.0	88.0	49.8
75S	M75	15.0	62.0	72.1	2.0	2.5	90.0	99.0	63.7
75	M75	15.0	68.0	78.5	2.5	3.0	100.0	110.0	57.3
90	M90	24.0	80.0	90.4	3.15	4.0	114.3	125.7	66.6

28th May 2021:Load calculations and Transformer sizing calculations

14		Load calculations	Calculations,procedure

	Load calculations and Transformer sizing calculations	Transformer sizing calculations	Calculations,procedure

Topic details:

Load calculations

ELECTRICAL LOAD CALCULATIONS LV MCC

Sl. No.	Equipment No.	Equipment Description	Breaker Rating	Breaker Type	Breaker No. of Poles	ELCB Rating	Absorbed Load [A]	Motor / Load Rating [B]	Load Factor [A] / [B] [C]	Efficiency at Load Factor [C] [D]	Power Factor at Load Factor [C]	Consumed Load (kW = [A] / [D]; kVAR = kW x tan φ) Continuous kW	Continuous kVAR	Intermittent kW	Intermittent kVAR	Stand-by kW	Stand-by kVAR	Remarks
			A			mA	kW	kW	decimal	decimal	cos φ	kW	kVAR	kW	kVAR	kW	kVAR	
1	PU2315	Silica filter feed pump					21.80	30.00	0.73	0.91	0.73	23.96	22.43					
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)					6.33	7.50	0.84	0.85	0.73	7.4	7.0					
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)					5.45	7.50	0.73	0.85	0.73					6.4	6.0	
4	PU2305	Feed Pump (Seperator)					22.01	30.00	0.73	0.91	0.78	24.2	19.4					
5	MX2305	MIXER (W)					22.18	30.00	0.74	0.91	0.78	24.4	19.6					
6	MX 2308	MIXER (S)					22.18	30.00	0.74	0.91	0.78					24.4	19.6	
7	BW2313	Blower					9.53	11.00	0.87	0.85	0.73	11.2	10.5					
8	Rotary valve	TK 2313B (I)					0.93	1.50	0.62	0.85	0.73			1.1	1.0			
9	SC2314	Screw conveyor (I)					2.14	3.00	0.71	0.85	0.73			2.52	2.36			
10	AG 2324A	Citric acid tan agitator (W)					1.60	3.00	0.53	0.85	0.73	1.88	1.76					
11	AG 2324B	Citric acid tank agitator (S)					1.60	3.00	0.53	0.85	0.73					1.9	1.8	
12	AG 2305	Citric oil rection vessol agitator					5.84	7.50	0.78	0.85	0.73	6.87	6.43					
13	AG 2309	Lye oil reaction vessel agitator					2.12	3.00	0.71	0.85	0.73	2.49	2.34					
14	AG 2310	Lye oil reaction vessel agitator					2.12	3.00	0.71	0.85	0.73	2.49	2.34					
15	AG 2314	Soap Adsorbant Tank Agitator					3.71	4.70	0.79	0.85	0.73	4.36	4.09					
											TOTAL	109.28	95.81	3.61	3.38	32.67	27.32	
											kVA	145.33		4.95		42.59		

Maximum of normal running plant load : 110.4 kW 96.8 kVAR sqrt (kW² +kVAR²) = 146.8 kVA
(Est. x%E + y%F)

Peak Load : 113.6 kW 99.6 kVAR sqrt (kW² +kVAR²) = 151.1 kVA
(Est. x%E + y%F + z%G)

Assumptions

1) Load factor, Efficiency and Power factor.

Load Rating (kW)	Efficiency	Power factor
<= 20	0.85	0.73
> 20 - <= 45	0.91	0.78
> 45 - < 150	0.93	0.82
>= 150	0.94	0.91

2) Coincidence factors x= 1.0, y= 0.3, and z=0.1 considered for contnious, intermittent and standby load.

Calculation for Transformer Capacity

1.0 Example of calculation for Transformer Capacity

1.1 Calculation for consumed load

Consumed loads used for this example are as follows :

	kW	kVar	kVA	
a. Continuous load	109.28	95.8	145.33	--- (i)
b. Intermittent load / Diversity Factor	3.61	3.4	4.95	--- (ii)
c. Stand-by load required as consumed load	32.67	27.3	42.59	--- (iii)
Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	113.6	99.6	151.07	
Future expansion load (20% capacity)	22.7	19.9	30.21	
Total Load =	136.4	119.5	181.29	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load	=	151.1 kVA
Spare capacity	=	30.2 kVA
Required capacity	=	181.3 kVA
Transformer rated capacity	=	190 kVA

1.3 Voltage regulation check

During starting or reacceleration of max. capacity motor (3400 kW) , while all the other loads running , the voltage regulation is as follows :

P_T = 190 KVA (%Z)= 4 & Ratio X/R = 3.3

Hence , **%R =** = 1.173 %

%X = = 3.82 %

P_M = 30 KW having (K = 6 & C = 1 & Cos θ = 0.78 & Eff.η = 0.91 & Cos Θs = 0.25

P_S = = 253.5926 KVA

Cos θ_S = 0.25 ,Corresponding to Angle θ_s = 75.52249 Degrees for which Sin θ_s = 0.97

P_B = 70.81 KVA & PB in KW is = 60.1885 & P_B in Kvar = 11.94 ∴ Cos θ_B = 0.850

Cos θ_B = 0.85 ,Corresponding to Angle θ_s = 31.78833 Degrees, for which Sin θ_s = 0.53

P_{CP} = = 123.5866 KW

P_{CQ} = = 257.4799 KVAR

P_C = = 285.6039 KVA

Cos θ_C = = 0.43272 , where as Sin θ_C = 0.902

Voltage Regulation ε = 5.9 %

Result: During starting of max. capacity motor, while all other loads are running , the voltage regulation at Transformer secondary terminals is approx. 5.3% , which meets the criteria to maintain less than 15% voltage regulation.

1.4 Selection of rated capacity

120 kVA transformer selected.

29th May 2021:DG set calculations

15	DG set calculations	DG set	Calculations,procedure

Topic details:

DG SIZING CALCULATIONS

	Design Data		
	Rated Volatge	415	KV
	Power factor (CosØ)	0.78	Avg
	Efficiency	0.91	Avg
	Err:509	**146.8**	
	Largest motor to start in the sequence - load in KW	30	KW
	Running kVA of last motor (CosØ= 0.91)	42	KVA
	Starting current ratio of motor	6	(Considering starting method as Soft starter)
	Starting KVA of the largest motor (Running kVA of last motor X Starting current ratio of motor)	**254**	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	**105**	KVA
A	**Continous operation under load -P1**		
	Capacity of DG set based on continuous operation under load P1	**105**	**KVA**
B	**Transient Voltage dip during starting of Last motor P2**		
	Total momentary load in KVA	358	KVA
	(Starting KVA of the last motor+Base load of DG set in KVA		
	Subtransient Reactance of Generator (Xd'')	7.91%	(Assumed)
	Transient Reactance of Generator (Xd')	10.065%	(Assumed)
	Xd''' =(Xd''+Xd')/2	0.089875	
	Transient Voltage Dip	15%	(Max)
	Transient Voltage dip during Soft starter starting of Last motor P2 = Total momentary load in KVA x Xd''' x (1-Transient Voltage Dip) / (Transient Voltage Dip)	**182**	**KVA**
C	**Overload capacity P3**		
	Capacity of DG set required considering overload capacity		
	Total momentary load in KVA	358	KVA
	overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)	150%	
	Capacity of DG set required considering overload capacity (P3) = Total momentary load in KVA / overcurrent capacity of DG (K)	**239**	**KVA**
	Considering the last value amongst P1, P2 and P3		
	Continous operation under load -P1	105	KVA
	Transient Voltage dip during Soft starter starting of Last motor P2	182	KVA
	Overload capacity P3	239	KVA
	Considering the last value amongst P1, P2 and P3	**239**	**KVA**
	selected rating	**315**	**KVA**

Hence, DG set 239 KVA is adequate to cater the loads as per re-scheduled loads

NOTE:VOLTAGE DIP CONSIDERED - 15%

2nd June 2021:Calculations of Earthing and Lightening protection

16	Calculations of Earthing and Lightening protection	Earthing calculations	Calculations,procedure
		Lightening protection calculations	Calculations,procedure

Topic details:

EARTHING CALCULATIONS

Maximum line-to-ground fault in kA for 1 sec	11	
Earthing material (Earth rod & earth strip)	GI	
Depth of earth flat burrial in meter	0.5	
Average depth / length of Earth rod in meters	3.5	
Soil resistivity Ω-meter	7.5	
Ambient temperature in deg C	45	
Plot dimensions (earth grid) L x B in meters	85	145
Number of earth rods in nos.	6	

Earth electrode sizing:

Ac - Required conductor cross section in sq.mm

$$I_g = A_c x \sqrt{\left[\frac{TCAPx10^{-4}}{t_c x \alpha_r x \rho_r}\right] x l_n \left[\frac{K_O + T_m}{K_o + T_a}\right]}$$

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
I_g - RMS fault current in kA = 50 KA	11
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP J/(cm3.oC)	3.93
Tm - Maximum allowable temperature for copper conductor, in oC	419
K0 - Factor at oC	293
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:	
11 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	90
Earth rod dia in mm	11
Earth rod dia (including 25% corrosion allowance) in mm	13

Earth flat sizing:

Ac - Required conductor cross section in sq.mm

$$I_g = A_c x \sqrt{\left[\frac{TCAPx10^{-4}}{t_c x \alpha_r x \rho_r}\right] x l_n \left[\frac{K_O + T_m}{K_o + T_a}\right]}$$

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
I_g - RMS fault current in kA = 50 KA	14
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP J/(cm3.oC)	3.93
Tm - Maximum allowable temperature for copper conductor, in oC	419
K0 - Factor at oC	293
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:	
14 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	114
Earth flat area in mm	12
Earth flat area (including 25% corrosion allowance) in mm	15
Selected flat size W * Thk in sq mm	20

Rg - Grid resistance

Grid resistance can be calculated using Eq. 52 of IEEE 80

$$R_g = \rho \left\{\frac{1}{L} + \frac{1}{\sqrt{20 \ x \ A}}\left[1 + \frac{1}{1 + h \sqrt{20 / A}}\right]\right\}$$

ρ - Soil resistivity in Ω-meter=	7.5
L - Total buried length of ground conductor in meter	460
h - Depth of burial in meter	0.5
A - Grid area in sq. meter	12325
Rg - Grid resistance	0.046

Rr - Earth Electrode resistance

Grid resistance can be calculated using Eq. 55 of IEEE 80

$$R_r = \frac{\rho}{2 \ x \ \pi \ x \ n_r \ x \ L_r}\left\{l_n\left[\frac{4 \ x \ L_r}{b}\right] - 1 + \frac{2 \ x \ k_1 \ x \ L_r}{\sqrt{A}}\left(\sqrt{n_r} - 1\right)^2\right\}$$

ρ - Soil resistivity in Ω-meter, 16.96	7.5
n - No of earth electrodes	6
Lr - Length of earth electrode in meter	3.5
b - Diameter of earth electrode in meter	0.020
k1 - co-efficient	1
A - Area of grid in square metre	12325
Rr - Earth Electrode resistance	3.239016

Grounding system resistance

Grounding system resistance can be calculated using equation 53 of IEEE 80 as follows:

$$R_s = \frac{R_g \ x \ R_2 - R_m{}^2}{R_g + R_2 - 2R_m}$$

R_m - Mutual ground resistance between the group of ground conductors, R_g and group of electrodes, R_r in Ω. Neglected R_m, since this is for homogenous soil

Rs - Total earthing system resistance 0.046 Ohms

The calculated resistance grounding system is less than the allowable 1 Ω value.

lightening calculations

Location	Jaipur			
Building	Srtuctural, Industrial			
Type of Building	Triangle Roofs (c)			
Building Length (L)	19			
Building breadth (W)	7			
Building Height (H)	7			

Risk Factor Calculation

1 **Collection Area (A_c)**

A_c		=	3.14*H*H+(2*H*L)	
			419.86	

2 **Probability of Being Struck (P)**

P		=	$A_c * N_g * 10^{-6}$	
			0.001175608	

3 **Overall weighing factor**

a) Use of structure (A)		=	1.0	
b) Type of construction (B)		=	0.8	
c) Contents or consequential effects (C)		=	0.8	
d) Degree of isolation (D)		=	1.0	
e) Type of country (E)		=	0.3	
Wo - Overall weighing factor		=	A * B * C * D * E	
		=	0.192	
4 **Overall Risk Factor**	Po	=	P * Wo	
	Po	=	0.0002257167	
	Pa		10^{-5}	

As per clause no. 9.7 of BS- 6651, suggested acceptable risk factor (Po) has been taken as 10^{-5}
Since Po > Pa lightning protection required.

5 **Air Terminations**

Perimeter of the building		=	2(L+W)	
		=	52	Mts.

6 **Down Conductors**

Perimeter of building		=	52	Mts.
No. of down conductors based on perimeter		=	3	Nos.

Hence 3 nos. of Down conductors have been selected.

Size of Down conductor = 20 X 2.5 mm Galvanized Steel Strip
(As per BS6651, lightning currents have very short duration, therefore thermal factors are of little consequence in deciding the cross-section of the conductor. The minimum size of Down conductors - 20mm X 2.5 mm Galvanized Steel Strip)

5th June 2021:Cable sizing and cable tray sizing calculations

17	Cable sizing and cable tray sizing calculations	Cable sizing	Calculations, procedure
		Cable traying calculations	Calculations, procedure

Topic details:

ASSIGNMENT 6

S.NO.	Description	Equipment No.	Description	Consumed Load KW	Load Rating KW	Voltage (V)	No. of ph	Full Load Current (A)	Motor Starting Current (A)	Load P.F. Running	SIN Φ Running	Motor P.F Staring	SIN Φ Staring	Type	No. of Runs	No. of Cores	Size (mm2)	Current Rating (A)	Derating factor k1	Derating factor k2	Derating factor k3	Derating factor k4	Overall Derating factor k	Derated Current (A)	Cable Length (M)	Cable Resistance (Ohms/kM)	Cable Reactance (Ohms/kM)	Voltage drop (Running) (V)	Voltage drop (Running) (%)	Voltage drop (Starting) (V)	Voltage drop (starting) (%)	Cable size result	OD of Cable (mm)	Gland size
1	LVMCC	PU2315	Silica filter feed pump	21.90	30.00	415	3	38.1	228.51	0.8	0.6	0.8	0.5	2	1	4.0	35	148	0.98	0.9	1	1	0.882	130.5	95	0.6710	0.0794	3.66	0.88	21.68	5.22	OK	24	20
2	LVMCC	PU 2314-A	Absorbent/Neutral oil pump (W)	5.48	7.50	415	3	9.5	57.13	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	95	3.9400	0.0902	5.02	1.21	30.05	7.24	OK	18	20s
3	LVMCC	PU 2314 -B	Absorbent/Neutral oil pump (S)	5.48	7.50	415	3	9.5	57.13	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	60	9.4800	0.1007	7.56	1.82	45.32	10.92	OK	16	20s
4	LVMCC	PU2305	Feed Pump (Seperator)	23.40	30.00	415	3	40.7	244.16	0.8	0.6	0.8	0.5	2	1	4.0	35	148	0.98	0.9	1	1	0.882	130.5	85	0.6710	0.0794	3.50	0.84	20.72	4.99	OK	24	20s
5	LVMCC	MX2305	MIXER (W)	23.40	30.00	415	3	40.7	244.16	0.8	0.6	0.8	0.5	2	1	4.0	35	148	0.98	0.9	1	1	0.882	130.5	75	0.6710	0.0794	3.09	0.74	18.28	4.41	OK	24	20s
6	LVMCC	MX 2308	MIXER (S)	23.40	30.00	415	3	40.7	244.16	0.8	0.6	0.8	0.5	2	1	4.0	35	148	0.98	0.9	1	1	0.882	130.5	105	0.6710	0.0794	4.33	1.04	25.60	6.17	OK	24	20s
7	LVMCC	BW2313	Blower	8.03	11.00	415	3	14.0	83.79	0.8	0.6	0.8	0.5	2	1	4.0	16	85	0.98	0.9	1	1	0.882	75.0	100	1.4700	0.0815	2.96	0.71	17.66	4.25	OK	21	20s
8	LVMCC	Rotary valve	TK 2313B (I)	1.10	1.50	415	3	1.9	11.43	0.8	0.6	0.8	0.5	2	1	4.0	4	38	0.98	0.9	1	1	0.882	33.5	100	5.9000	0.0947	1.58	0.38	9.43	2.27	OK	17	20s
9	LVMCC	SC2314	Screw conveyor (I)	2.19	3.00	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	1.59	0.38	9.49	2.29	OK	18	20
10	LVMCC	AG 2324A	Citric acid tan agitator (W)	2.19	3.00	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	110	9.4800	0.1007	5.55	1.34	33.24	8.01	OK	16	20s
11	LVMCC	AG 2324B	Citric acid tank agitator (S)	2.19	3.00	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	75	3.9400	0.0902	1.59	0.38	9.49	2.29	OK	18	20
12	LVMCC	AG 2305	Citric oil rection vessel agitator	5.48	7.50	415	3	9.5	57.13	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1	0.882	45.0	105	3.9400	0.0902	5.55	1.34	33.22	8.00	OK	18	20
13	LVMCC	AG 2309	Lye oil reaction vessel agitator	2.19	3.00	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	25	122	0.98	0.9	1	1	0.882	107.6	85	0.9300	0.0816	0.44	0.11	2.64	0.64	OK	22	32
14	LVMCC	AG 2310	Lye oil reaction vessel agitator	2.19	3.00	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	95	9.4800	0.1007	4.79	1.15	28.70	6.92	OK	16	20s
15	LVMCC	AG 2314	Soap Adsorbant Tank Agitator	3.43	4.70	415	3	6.0	35.80	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1	0.882	24.7	65	9.4800	0.1007	5.14	1.24	30.77	7.41	OK	16	20s

Basis:

1. Overall derating factor k = k1 x k2 x k3 x k4

   K1=Rating factor for variation in air/ground temperature

   K2=Rating factor for depth of laying

   K3=Rating factor for spacing between two circuits

   K4=Rating factor for variation in thermal resistivity of the soil

2. LT Motors : Running Voltage Drop = 3%, Starting Voltage Drop = 15%

3. Cable type:

   TYPE 1: Al Conductor, XLPE Insulated, Armoured, PVC outer sheathed

   TYPE 2: Cu Conductor, XLPE Insulated, Armoured, PVC outer sheathed

4. Effect of Frequency Variation ± 5%

5. Combined Effect of Voltage & Frequency Variation ±10%

ASSIGNMENT-7

LT CABLES

CABLE TRAY: FROM		LT-4		TO	LT-5				
Sr. No.	**Cable Route (From-To)**	**Type & Cable Size**	**Size of Cable (mm2)**	**No. of Cable**	**Overall Diameter of each Cable (mm)**	**Sum of Cable OD (mm)**	**Self Weight of Cable (Kg/Mt)**	**Total Weight of Cable (Kg/Mt)**	**Remarks**
1	LV MCC	4	35	1	24	**24**	1.8	**1.8**	
2	PU2315- VFD	4	35	1	24	**24**	1.8	**1.8**	
3	PU2315- VFD	5	1.5	1	15	**15**	0.4	**0.4**	
4	LV MCC	4	6	1	18	**18**	0.7	**0.7**	
5	LV MCC	5	1.5	1	15	**15**	0.4	**0.4**	
6	LV MCC	4	2.5	1	16	**16**	0.5	**0.5**	
7	PU 2314 -B- VFD	4	2.5	1	16	**16**	0.5	**0.5**	
8	PU 2314 -B- VFD	5	1.5	1	15	**15**	0.4	**0.4**	
9	LV MCC	4	35	1	24	**24**	1.8	**1.8**	
10	PU2305- VFD	4	35	1	24	**24**	1.8	**1.8**	
11	PU2305- VFD	5	1.5	1	15	**15**	0.4	**0.4**	
12	LV MCC	4	35	1	24	**24**	1.8	**1.8**	
13	LV MCC	5	1.5	1	15	**15**	0.4	**0.4**	
14	LV MCC	4	35	1	24	**24**	1.8	**1.8**	
15	LV MCC	5	1.5	1	15	**15**	0.4	**0.4**	
16	LV MCC	4	16	1	21	**21**	1	**1**	
17	BW2313- VFD	4	16	1	21	**21**	1	**1**	
18	BW2313- VFD	5	1.5	1	15	**15**	0.4	**0.4**	
19	LV MCC	4	4	1	17	**17**	0.6	**0.6**	
20	LV MCC	5	1.5	1	15	**15**	0.4	**0.4**	
21	LV MCC	4	6	1	18	**18**	0.7	**0.7**	
	Total			**21**		**391**	**19**	**19**	

Calculation

Maximum Cable Diameter:	**24**	**mm**	**Result**			
Consider Spare Capacity of Cable Tray:	**30%**		**Selected Cable Tray width:**	**O.K**		
Distance between each Cable:	**0**	**mm**	**Selected Cable Tray Depth:**	**O.K**		
Calculated Width of Cable Tray:	**508**	**mm**	**Selectrd Cable Tray Weight:**	**O.K**	**Including Spare Capacity**	
Calculated Area of Cable Tray:	**12199**	**Sq.mm**	**Selected Cable Tray Size:**	**O.K**	**Including Spare Capacity**	
No of Layer of Cables in Cable Tray:	**2**		**Required Cable Tray Size:**	**300 x 150**	**mm**	
Selected No of Cable Tray:	**1**	**Nos.**	**Required Nos of Cable Tray:**	**1**	**No**	
Selected Cable Tray Width:	**300**	**mm**	**Required Cable Tray Weight:**	**50.00**	**Kg/Meter/Tray**	
Selected Cable Tray Depth:	**150**	**mm**	**Type of Cable Tray:**	**Ladder**		
Selected Cable Tray Weight Capacity:	**50**	**Kg/Meter**				
Type of Cable Tray:	**Ladder**		**Cable Tray Width Area Remaning**	**15%**		
Total Area of Cable Tray:	**45000**	**Sq.mm**	**Cable Tray Area Remaning:**	**73%**		

Conclusion

We have been taught many aspects of engineering activities during the EPC stages for all electrical and related other disciplines also.

Feedback

Smart Bridge

They conduct summer internships, work shops, debates, hackthons, technical sessions.

Method of conducting program

Online virtual program with presentation slides and explanation on the topic and practical usage of topic and with some examples.

Program highlights

It is for the detailed design of any industrial sectors.

Material

The material was good.

Benefits

It has been given the opportunity to learn and interact with industry experienced engineering specialist to learn the Electrical detailed design enginnering for various industrial sectors.

ASSIGNMENT-1

ELECTRICAL LOAD CALCULATIONS LV MCC

Sl. No.	Equipment No.	Equipment Description	Breaker Rating	Breaker Type	Breaker No. of Poles	ELCB Rating	Absorbed Load [A]	Motor / Load Rating [B]	Load Factor [A] / [B] [C]	Efficiency at Load Factor [C] [D]	Power Factor at Load Factor [C]	Consumed Load: kW = [A] / [D] — Continuous		Intermittent		Stand-by: kVAR = kW x tan φ		Remarks
			A			mA	kW	kW	decimal	decimal	cos φ	kW	kVAR	kW	kVAR	kW	kVAR	
1	PU2315	Silica filter feed pump					21.80	30.00	0.73	0.91	0.73	23.96	22.43					
2	PU 2314-A	Absorbesnt/Neutral oil pump (W)					6.33	7.50	0.84	0.85	0.73	7.4	7.0					
3	PU 2314 -B	Absorbesnt/Neutral oil pump (S)					5.45	7.50	0.73	0.85	0.73					6.4	6.0	
4	PU2305	Feed Pump (Seperator)					22.01	30.00	0.73	0.91	0.78	24.2	19.4					
5	MX2305	MIXER (W)					22.18	30.00	0.74	0.91	0.78	24.4	19.6					
6	MX 2308	MIXER (S)					22.18	30.00	0.74	0.91	0.78					24.4	19.6	
7	BW2313	Blower					9.53	11.00	0.87	0.85	0.73	11.2	10.5					
8	Rotary valve	TK 2313B (I)					0.93	1.50	0.62	0.85	0.73			1.1	1.0			
9	SC2314	Screw conveyor (I)					2.14	3.00	0.71	0.85	0.73			2.52	2.36			
10	AG 2324A	Citric acid tan agitator (W)					1.60	3.00	0.53	0.85	0.73	1.88	1.76					
11	AG 2324B	Citric acid tank agitator (S)					1.60	3.00	0.53	0.85	0.73					1.9	1.8	
12	AG 2305	Citric oil rection vessol agitator					5.84	7.50	0.78	0.85	0.73	6.87	6.43					
13	AG 2309	Lye oil reaction vessel agitator					2.12	3.00	0.71	0.85	0.73	2.49	2.34					
14	AG 2310	Lye oil reaction vessel agitator					2.12	3.00	0.71	0.85	0.73	2.49	2.34					
15	AG 2314	Soap Adsorbant Tank Agitator					3.71	4.70	0.79	0.85	0.73	4.36	4.09					
		Maximum of normal running plant load : 110.4 kW; 96.8 kVAR; sqrt (kW² +kVAR²) = 146.8 kVA (Est. x%E + y%F)									TOTAL	109.28	95.81	3.61	3.38	32.67	27.32	
		Peak Load : 113.6 kW; 99.6 kVAR; sqrt (kW² +kVAR²) = 151.1 kVA (Est. x%E + y%F + z%G)									kVA	145.33		4.95		42.59		

Assumptions

1) Load factor, Efficiency and Power factor.

Load Rating (kW)	Efficiency	Power factor
<= 20	0.85	0.73
> 20 - <= 45	0.91	0.78
> 45 - < 150	0.93	0.82
>= 150	0.94	0.91

2) Coincidence factors x= 1.0, y= 0.3, and z=0.1 considered for contnious, intermittent and standby load.

ASSIGNMENT-2

Calculation for Transformer Capacity

1.0 Example of calculation for Transformer Capacity

1.1 Calculation for consumed load

Consumed loads used for this example are as follows :

		kW	kVar	kVA	
a.	Continuous load	109.28	95.8	145.33	--- (i)
b.	Intermittent load / Diversity Factor	3.61	3.4	4.95	--- (ii)
c.	Stand-by load required as consumed load	32.67	27.3	42.59	--- (iii)
	Max. Consumed load = ((i) + 30% (ii) + 10% (iii)) =	113.6	99.6	151.07	
	Future expansion load (20% capacity)	22.7	19.9	30.21	
	Total Load =	136.4	119.5	181.29	

1.2 Calculation for 3.3kV / 0.433 kV transformer capacity

Max. Consumed load	=	151.1 kVA
Spare capacity	=	30.2 kVA
Required capacity	=	181.3 kVA
Transformer rated capacity	=	190 kVA

1.3 Voltage regulation check

During starting or reacceleration of max. capacity motor (3400 kW) , while all the other loads running , the voltage regulation is as follows :

P_T = 190 KVA (%Z)= 4 & Ratio X/R = 3.3

Hence , **%R** = = 1.173 %

%X = = 3.82 %

P_M = 30 KW having (K = 6 & C = 1 & Cos θ = 0.78 & Eff.η = 0.91 & Cos Θs = 0.25

P_S = = 253.5926 KVA

Cos θ_S = 0.25 ,Corresponding to Angle θ_s = 75.52249 Degrees for which Sin θ_s = 0.97

P_B = 70.81 KVA & PB in KW is = 60.1885 & P_B in Kvar = 11.94 ∴ Cos θ_B = 0.850

Cos θ_B = 0.85 ,Corresponding to Angle θ_s = 31.78833 Degrees, for which Sin θ_s = 0.53

P_{CP} = = 123.5866 KW

P_{CQ} = = 257.4799 KVAR

P_C = = 285.6039 KVA

Cos θ_C = = 0.43272 , where as Sin θ_C = 0.902

Voltage Regulation ε = 5.9 %

Result: During starting of max. capacity motor, while all other loads are running , the voltage regulation at Transformer secondary terminals is approx. 5.3% , which meets the criteria to maintain less than 15% voltage regulation.

1.4 Selection of rated capacity

120 kVA transformer selected.

ASSIGNMENT-3

DG SIZING CALCULATIONS

	Design Data		
	Rated Volatge	415	KV
	Power factor (CosØ)	0.78	Avg
	Efficiency	0.91	Avg
	Err:509	**146.8**	
	Largest motor to start in the sequence - load in KW	30	KW
	Running kVA of last motor (CosØ= 0.91)	42	KVA
	Starting current ratio of motor	6	(Considering starting method as Soft starter)
	Starting KVA of the largest motor (Running kVA of last motor X Starting current ratio of motor)	**254**	KVA
	Base load of DG set in KVA (Total operating load in kVA – Running kVA of last motor)	**105**	KVA
A	**Continous operation under load -P1**		
	Capacity of DG set based on continuous operation under load P1	**105**	**KVA**
B	**Transient Voltage dip during starting of Last motor P2**		
	Total momentary load in KVA (Starting KVA of the last motor+Base load of DG set in KVA	358	KVA
	Subtransient Reactance of Generator (Xd'')	7.91%	(Assumed)
	Transient Reactance of Generator (Xd')	10.065%	(Assumed)
	Xd''' =(Xd"+Xd')/2	0.089875	
	Transient Voltage Dip	15%	(Max)
	Transient Voltage dip during Soft starter starting of Last motor P2 = Total momentary load in KVA x Xd''' x (1-Transient Voltage Dip) / (Transient Voltage Dip)	**182**	**KVA**
C	**Overload capacity P3**		
	Capacity of DG set required considering overload capacity		
	Total momentary load in KVA	358	KVA
	overcurrent capacity of DG (K) (Ref: IS/IEC 60034-1, Clause 9.3.2)	150%	
	Capacity of DG set required considering overload capacity (P3) = Total momentary load in KVA / overcurrent capacity of DG (K)	**239**	**KVA**
	Considering the last value amongst P1, P2 and P3		
	Continous operation under load -P1	105	KVA
	Transient Voltage dip during Soft starter starting of Last motor P2	182	KVA
	Overload capacity P3	239	KVA
	Considering the last value amongst P1, P2 and P3	**239**	**KVA**
	selected rating	**315**	**KVA**
	Hence, DG set 239 KVA is adequate to cater the loads as per re-scheduled loads		
	NOTE:VOLTAGE DIP CONSIDERED - 15%		

ASSIGNMENT-4

EARTHING CALCULATIONS

Maximum line-to-ground fault in kA for 1 sec	11	
Earthing material (Earth rod & earth strip)	GI	
Depth of earth flat burrial in meter	0.5	
Average depth / length of Earth rod in meters	3.5	
Soil resistivity Ω-meter	7.5	
Ambient temperature in deg C	45	
Plot dimensions (earth grid) L x B in meters	85	145
Number of earth rods in nos.	6	

Earth electrode sizing:
Ac - Required conductor cross section in sq.mm

$$I_{lg} = A_c x \sqrt{\left[\frac{TCAPx10^{-4}}{t_c x \alpha_r x \rho_r}\right] x l_n \left[\frac{K_0 + T_m}{K_0 + T_a}\right]}$$

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
$I_{l\text{-}g}$ - RMS fault current in kA = 50 KA	11
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP J/(cm3.oC)	3.93
Tm - Maximum allowable temperature for copper conductor, in oC	419
K0 - Factor at oC	293
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:	
11 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	90
Earth rod dia in mm	11
Earth rod dia (including 25% corrosion allowance) in mm	13

Earth flat sizing:
Ac - Required conductor cross section in sq.mm

$$I_{lg} = A_c x \sqrt{\left[\frac{TCAPx10^{-4}}{t_c x \alpha_r x \rho_r}\right] x l_n \left[\frac{K_0 + T_m}{K_0 + T_a}\right]}$$

αr - Thermal co-efficient of resistivity, at 20 oC	0.0032
ρr - Resistivity of ground conductor at 20 oC	20.10
Ta - Ambient Temperature is °C	50
$I_{l\text{-}g}$ - RMS fault current in kA = 50 KA	14
tc - Short circuit current duration sec	1
Thermal capacity factor, TCAP J/(cm3.oC)	3.93
Tm - Maximum allowable temperature for copper conductor, in oC	419
K0 - Factor at oC	293
The data taken from IEEE 80-2000, Clause 11.3, Table-1 for clad steel rod:	
14 = Ac *	0.123
Ac - Required conductor cross section in sq.mm	114

Earth flat area in mm	12
Earth flat area (including 25% corrosion allowance) in mm	15
Selected flat size W * Thk in sq mm	20

Rg - Grid resistance
Grid resistance can be calculated using Eq. 52 of IEEE 80

$$R_g = \rho \left\{ \frac{1}{L} + \frac{1}{\sqrt{20 \ x \ A}}\left[1 + \frac{1}{1 + h \sqrt{20 \ /A}}\right]\right\}$$

ρ - Soil resistivity in Ω-meter=	7.5
L - Total buried length of ground conductor in meter	460
h - Depth of burial in meter	0.5
A - Grid area in sq. meter	12325
Rg - Grid resistance	0.046

Rr - Earth Electrode resistance
Grid resistance can be calculated using Eq. 55 of IEEE 80

$$R_r = \frac{\rho}{2 \ x \ \pi \ x \ n_r \ x \ L_r}\left\{ l_n \left[\frac{4 \ x \ L_r}{b}\right] - 1 + \frac{2 \ x \ k_1 \ x \ L_r}{\sqrt{A}}\left(\sqrt{n_r} - 1\right)^2\right\}$$

ρ - Soil resistivity in Ω-meter, 16.96	7.5
n - No of earth electrodes	6
Lr - Length of earth electrode in meter	3.5
b - Diameter of earth electrode in meter	0.020
k1 - co-efficient	1
A - Area of grid in square metre	12325
Rr - Earth Electrode resistance	3.239016

Grounding system resistance
Grounding system resistance can be calculated using equation 53 of IEEE 80 as follows:

$$R_s = \frac{R_g \ x \ R_2 - {R_m}^2}{R_g + R_2 - 2R_m}$$

R_m - Mutual ground resistance between the group of ground conductors, R_g and group of electrodes, R_r in Ω. Neglected R_m, since this is for homogenous soil

Rs - Total earthing system resistance 0.046 Ohms
The calculated resistance grounding system is less than the allowable 1 Ω value.

ASSIGNMENT-5

lightening calculations

Location	Jaipur
Building	Srtuctural, Industrial
Type of Building	Triangle Roofs (c)
Building Length (L)	19
Building breadth (W)	7
Building Height (H)	7

Risk Factor Calculation

1 **Collection Area (A_c)**

A_c		=	3.14*H*H+(2*H*L)	
			419.86	

2 **Probability of Being Struck (P)**

P		=	$A_c * N_g * 10^{-6}$	
			0.001175608	

3 **Overall weighing factor**

a) Use of structure (A)		=	1.0	
b) Type of construction (B)		=	0.8	
c) Contents or consequential effects (C)		=	0.8	
d) Degree of isolation (D)		=	1.0	
e) Type of country (E)		=	0.3	
Wo - Overall weighing factor		=	A * B * C * D * E	
		=	0.192	

4 **Overall Risk Factor**	Po	=	P * Wo	
	Po	=	0.0002257167	
	Pa		10^{-5}	

As per clause no. 9.7 of BS- 6651, suggested acceptable risk factor (Po) has been taken as 10^{-5}
Since Po > Pa lightning protection required.

5 **Air Terminations**

Perimeter of the building		=	2(L+W)	
		=	52	Mts.

6 **Down Conductors**

Perimeter of building		=	52	Mts.
No. of down conductors based on perimeter		=	3	Nos.

Hence 3 nos. of Down conductors have been selected.

Size of Down conductor = 20 X 2.5 mm Galvanized Steel Strip
(As per BS6651, lightning currents have very short duration, therefore thermal factors are of little consequence in deciding the cross-section of the conductor. The minimum size of Down conductors - 20mm X 2.5 mm Galvanized Steel Strip)

ASSIGNMENT-6

S.NO.	Description	Equipment No.	Description	Consumed Load KW	Load Rating KW	Voltage (V)	No. of ph	Full Load Current (A)	Motor Starting Current (A)	Load P.F. Running	SIN Φ Running	Motor P.F Staring	SIN Φ Staring	Type	No. of Runs	No. of Cores	Size (mm2)	Current Rating (A)	Derating factor k1	Derating factor k2	Derating factor k3	Derating factor k4
1	LV MCC	PU2315	Silica filter feed pump	21.90	30.00	415	3	38.1	228.51	0.8	0.6	0.8	0.5	2	1	4.0	35	148	0.98	0.9	1	1
2	LV MCC	PU 2314-A	Absorbesnt/Neutral oil pump (W)	5.48	7.50	415	3	9.5	57.13	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1
3	LV MCC	PU 2314 -B	Absorbesnt/Neutral oil pump (S)	5.48	7.50	415	3	9.5	57.13	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1
4	LV MCC	PU2305	Feed Pump (Seperator)	23.40	30.00	415	3	40.7	244.16	0.8	0.6	0.8	0.5	2	1	4.0	35	148	0.98	0.9	1	1
5	LV MCC	MX2305	MIXER (W)	23.40	30.00	415	3	40.7	244.16	0.8	0.6	0.8	0.5	2	1	4.0	35	148	0.98	0.9	1	1
6	LV MCC	MX 2308	MIXER (S)	23.40	30.00	415	3	40.7	244.16	0.8	0.6	0.8	0.5	2	1	4.0	35	148	0.98	0.9	1	1
7	LV MCC	BW2313	Blower	8.03	11.00	415	3	14.0	83.79	0.8	0.6	0.8	0.5	2	1	4.0	16	85	0.98	0.9	1	1
8	LV MCC	Rotary valve	TK 2313B (I)	1.10	1.50	415	3	1.9	11.43	0.8	0.6	0.8	0.5	2	1	4.0	4	38	0.98	0.9	1	1
9	LV MCC	SC2314	Screw conveyor (I)	2.19	3.00	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1
10	LV MCC	AG 2324A	Citric acid tan agitator (W)	2.19	3.00	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1
11	LV MCC	AG 2324B	Citric acid tank agitator (S)	2.19	3.00	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1
12	LV MCC	AG 2305	Citric oil rection vessol agitator	5.48	7.50	415	3	9.5	57.13	0.8	0.6	0.8	0.5	2	1	4.0	6	51	0.98	0.9	1	1
13	LV MCC	AG 2309	Lye oil reaction vessel agitator	2.19	3.00	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	25	122	0.98	0.9	1	1
14	LV MCC	AG 2310	Lye oil reaction vessel agitator	2.19	3.00	415	3	3.8	22.85	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1
15	LV MCC	AG 2314	Soap Adsorbant Tank Agitator	3.43	4.70	415	3	6.0	35.80	0.8	0.6	0.8	0.5	2	1	4.0	2.5	28	0.98	0.9	1	1

S.NO.	Overall Derating factor k	Derated Current (A)	Cable Length (M)	Cable Resistance (Ohms/kM)	Cable Reactance (Ohms/kM)	Voltage drop (Running) (V)	Voltage drop (Running) (%)	Voltage drop (Starting) (V)	Voltage drop (starting) (%)	Cable size result	OD of Cable (mm)	Gland size
1	0.882	130.5	95	0.6710	0.0794	3.66	0.88	21.68	5.22	OK	24	20
2	0.882	45.0	95	3.9400	0.0902	5.02	1.21	30.05	7.24	OK	18	20s
3	0.882	24.7	60	9.4800	0.1007	7.56	1.82	45.32	10.92	OK	16	20s
4	0.882	130.5	85	0.6710	0.0794	3.50	0.84	20.72	4.99	OK	24	20s
5	0.882	130.5	75	0.6710	0.0794	3.09	0.74	18.28	4.41	OK	24	20s
6	0.882	130.5	105	0.6710	0.0794	4.33	1.04	25.60	6.17	OK	24	20s
7	0.882	75.0	100	1.4700	0.0815	2.96	0.71	17.66	4.25	OK	21	20s
8	0.882	33.5	100	5.9000	0.0947	1.58	0.38	9.43	2.27	OK	17	20s
9	0.882	45.0	75	3.9400	0.0902	1.59	0.38	9.49	2.29	OK	18	20
10	0.882	24.7	110	9.4800	0.1007	5.55	1.34	33.24	8.01	OK	16	20s
11	0.882	45.0	75	3.9400	0.0902	1.59	0.38	9.49	2.29	OK	18	20
12	0.882	45.0	105	3.9400	0.0902	5.55	1.34	33.22	8.00	OK	18	20
13	0.882	107.6	85	0.9300	0.0816	0.44	0.11	2.64	0.64	OK	22	32
14	0.882	24.7	95	9.4800	0.1007	4.79	1.15	28.70	6.92	OK	16	20s
15	0.882	24.7	65	9.4800	0.1007	5.14	1.24	30.77	7.41	OK	16	20s

Basis:

1. Overall derating factor k = k1 x k2 x k3 x k4

    K1=Rating factor for variation in air/ground temperature

    K2=Rating factor for depth of laying

    K3=Rating factor for spacing between two circuits

    K4=Rating factor for variation in thermal resistivity of the soil

2. LT Motors : Running Voltage Drop = 3%, Starting Voltage Drop = 15%
3. Cable type:

    TYPE 1: Al Conductor, XLPE Insulated, Armoured, PVC outer sheathed

    TYPE 2: Cu Conductor, XLPE Insulated, Armoured, PVC outer sheathed

4. Effect of Frequency Variation ± 5%
5. Combined Effect of Voltage & Frequency Variation ±10%

ASSIGNMENT-7

LT CABLES

CABLE TRAY: FROM		LT-4		TO	LT-5				
Sr. No.	**Cable Route (From-To)**	**Type & Cable Size**	**Size of Cable (mm2)**	**No. of Cable**	**Overall Diameter of each Cable (mm)**	**Sum of Cable OD (mm)**	**Self Weight of Cable (Kg/Mt)**	**Total Weight of Cable (Kg/Mt)**	**Remarks**
1	LV MCC	4	35	1	24	**24**	1.8	**1.8**	
2	PU2315- VFD	4	35	1	24	**24**	1.8	**1.8**	
3	PU2315- VFD	5	1.5	1	15	**15**	0.4	**0.4**	
4	LV MCC	4	6	1	18	**18**	0.7	**0.7**	
5	LV MCC	5	1.5	1	15	**15**	0.4	**0.4**	
6	LV MCC	4	2.5	1	16	**16**	0.5	**0.5**	
7	PU 2314 -B- VFD	4	2.5	1	16	**16**	0.5	**0.5**	
8	PU 2314 -B- VFD	5	1.5	1	15	**15**	0.4	**0.4**	
9	LV MCC	4	35	1	24	**24**	1.8	**1.8**	
10	PU2305- VFD	4	35	1	24	**24**	1.8	**1.8**	
11	PU2305- VFD	5	1.5	1	15	**15**	0.4	**0.4**	
12	LV MCC	4	35	1	24	**24**	1.8	**1.8**	
13	LV MCC	5	1.5	1	15	**15**	0.4	**0.4**	
14	LV MCC	4	35	1	24	**24**	1.8	**1.8**	
15	LV MCC	5	1.5	1	15	**15**	0.4	**0.4**	
16	LV MCC	4	16	1	21	**21**	1	**1**	
17	BW2313- VFD	4	16	1	21	**21**	1	**1**	
18	BW2313- VFD	5	1.5	1	15	**15**	0.4	**0.4**	
19	LV MCC	4	4	1	17	**17**	0.6	**0.6**	
20	LV MCC	5	1.5	1	15	**15**	0.4	**0.4**	
21	LV MCC	4	6	1	18	**18**	0.7	**0.7**	
Total				**21**		**391**	**19**	**19**	

Calculation

Maximum Cable Diameter:	**24**	**mm**
Consider Spare Capacity of Cable Tray:	**30%**	
Distance between each Cable:	**0**	**mm**
Calculated Width of Cable Tray:	**508**	**mm**
Calculated Area of Cable Tray:	**12199**	**Sq.mm**
No of Layer of Cables in Cable Tray:	**2**	
Selected No of Cable Tray:	**1**	**Nos.**
Selected Cable Tray Width:	**300**	**mm**
Selected Cable Tray Depth:	**150**	**mm**
Selected Cable Tray Weight Capacity:	**50**	**Kg/Meter**
Type of Cable Tray:	**Ladder**	
Total Area of Cable Tray:	**45000**	**Sq.mm**

Result

Selected Cable Tray width:	**O.K**	
Selected Cable Tray Depth:	**O.K**	
Selectrd Cable Tray Weight:	**O.K**	**Including Spare Capacity**
Selected Cable Tray Size:	**O.K**	**Including Spare Capacity**
Required Cable Tray Size:	**300 x 150**	**mm**
Required Nos of Cable Tray:	**1**	**No**
Required Cable Tray Weight:	**50.00**	**Kg/Meter/Tray**
Type of Cable Tray:	**Ladder**	
Cable Tray Width Area Remaning	**15%**	
Cable Tray Area Remaning:	**73%**	